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October 3, 2012

By Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth St., S.W.
Washington, D.C. 20554

Re: Promoting Interoperability in the 700 MHz Commercial Spectrum, WT Docket No. 12-69

Dear Ms. Dortch:

AT&T Inc. ("AT&T") submits the attached paper entitled "Analysis of the V-Comm Report Estimating the Impact of Channel 51 and E Block Interference on Band 12 and Band 17 User Equipment Receivers," by Professor Jeffrey H. Reed and Dr. Nishith D. Tripathi, both of whom have previously submitted papers in this proceeding.[1]

In this paper, Prof. Reed and Dr. Tripathi evaluate the analysis submitted by V-Comm L.L.C. ("V-Comm") on July 13, 2012 ("V-Comm Report"), which purports to show – contrary to multiple other tests and analyses presented in this proceeding – that the geographic area where Channel 51 and E block signals can be expected to degrade performance for Band 12 devices, but not for Band 17 devices, is relatively small. Professor Reed and Dr. Tripathi conclude, "[u]pon careful review of the V-Comm Report and of the results of further testing conducted by 7Layers (a well-regarded independent testing firm)," that "it is apparent that the conclusions in the V-Comm Report are wrong and reflect incorrect assumptions, parameters and methodologies."

[1] *See* Jeffrey H. Reed and Nishith D. Tripathi, *Impact of Channel 51 and E Block Interference On Band 12 and Band 17 User Equipment Receivers* (June 1, 2012), attached as Exhibit A to Comments of AT&T Inc., *Promoting Interoperability in the 700 MHz Commercial Spectrum*, WT Docket No. 12-69 (June 1, 2012); Jeffrey H. Reed and Nishith D. Tripathi, *Supplemental Analysis: Impact of Channel 51 and E Block Interference On Band 12 and Band 17 User Equipment Receivers* (July 16, 2012), attached as Attachment A to Reply Comments of AT&T Inc., *Promoting Interoperability in the 700 MHz Commercial Spectrum*, WT Docket No. 12-69 (July 16, 2012).

Professor Reed and Dr. Tripathi identify numerous significant problems with the V-Comm Report. First, they show that V-Comm's Channel 51 and E block tests examined interference under conditions where interference is least likely to occur, while ignoring other very common real world conditions where Channel 51 and E block interference will cause substantial harm to performance for Band 12 devices, but not for Band 17 devices. In particular, V-Comm's tests assume that customers will use their devices only where LTE signals are relatively strong, and only where there are only one or two people in an entire cell attempting to access data at a time. In the real world, however, customers use their mobile devices everywhere, including in locations farther from a cell site, indoors, and in other locations where LTE signal levels are lower, and there often will be many customers transmitting and receiving data at any given time. As multiple other tests have confirmed, under these common scenarios, interference from Channel 51 and E block signals will significantly degrade performance of Band 12 devices, but not Band 17 devices, in large geographic areas, including in urban areas.

Second, Professor Reed and Dr. Tripathi identify fundamental problems with V-Comm's Channel 51 field measurements, conducted in Waterloo, Iowa, where U.S. Cellular is apparently now operating a Band 12 network using the B and C blocks. They explain, for example, that, according to the maps in the V-Comm Report, those field measurements were obtained in areas located many miles from the Channel 51 transmitters (often 40 miles or more) where Channel 51 signal levels are below those that tend to cause interference. That is like looking for snow by the equator and concluding from its absence that snow does not exist. And, because the report discloses only averages of the field test readings, poor performance measured in the very small portion of drive test route nearby the Channel 51 station would be masked by the large number of test points in areas where Channel 51 signal levels are necessarily very low.

Third, Professor Reed and Dr. Tripathi explain why V-Comm's E block analysis, which relies upon modeling to guess at the locations where E block signals will be high enough to cause interference, rather than the real world signal level measurements submitted by Qualcomm, is equally flawed. They explain that the model used by V-Comm, the TM 91-1, is simplistic and not suitable for assessing E block interference. For example, the TM 91-1 model is designed for transmitter heights under 300 feet, even though Qualcomm's deployment of MediaFlo used transmitters that were often placed well above 300 feet. The model also assumes that signals will travel the same distance in both rural and urban areas, even though urban areas typically have large buildings that block signals and cause them to bounce around. The model incorrectly assumes that all frequencies have the same propagation characteristics. And, as noted, here, too, V-Comm's testing protocols assumed unreasonably high LTE signal levels and unreasonably large allocations of uplink and downlink resources to the tested devices.

Very truly yours,

/s/ David L. Lawson
David L. Lawson

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Analysis of the V-COMM Report Estimating the Impact of Channel 51 and E Block Interference on Band 12 and Band 17 User Equipment Receivers

Jeffrey H. Reed and Nishith D. Tripathi

Reed Engineering

This supplemental paper[1] describes our evaluation of the analysis submitted by V-COMM L.L.C. ("V-COMM"), which purports to compare the impact of interference from Channel 51 and E block transmissions on Band 12 and Band 17 devices.[2] The V-COMM Report concludes – contrary to multiple other tests and analyses – that although Band 12 devices are far more susceptible to interference from Channel 51 and E block signals than are Band 17 devices, the Channel 51 and E block signal levels required to cause such interference are so high as to be irrelevant in most real world situations. Upon careful review of the V-COMM Report and of the results of further testing conducted by 7Layers (a well-regarded independent testing firm), it is apparent that the conclusions in the V-COMM Report are wrong and reflect incorrect assumptions, parameters and methodologies.

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[1] We have submitted two prior papers in this proceeding. *See* Jeffrey H. Reed and Nishith D. Tripathi, *Impact of Channel 51 and E Block Interference On Band 12 and Band 17 User Equipment Receivers* (June 1, 2012), attached as Exhibit A to Comments of AT&T Inc., *Promoting Interoperability in the 700 MHz Commercial Spectrum*, WT Docket No. 12-69 (June 1, 2012) ("R-T 6/1 Paper"); Jeffrey H. Reed and Nishith D. Tripathi, *Supplemental Analysis: Impact of Channel 51 and E Block Interference On Band 12 and Band 17 User Equipment Receivers* (July 16, 2012), attached as Attachment A to Reply Comments of AT&T Inc., *Promoting Interoperability in the 700 MHz Commercial Spectrum*, WT Docket No. 12-69 (July 16, 2012) ("R-T 7/16 Paper").

[2] Reply Comments of V-COMM, LLC Prepared on Behalf of Cavalier Wireless, Continuum 700, King Street Wireless, MetroPCS Communications, Inc., Vulcan Wireless LLC, WT Docket No. 12-69 (July 13, 2012) ("V-COMM Report").

EXECUTIVE SUMMARY

V-COMM's Channel 51 Interference Testing. Consistent with the other testing and analyses we have reviewed, the V-COMM Report confirms that in large geographic areas, including in urban areas, Channel 51 signal levels are often in the range of -40 dBm to -20 dBm.[3] As we demonstrated in our prior papers, multiple tests and analyses confirm that, at Channel 51 signal levels in this range, Band 12 devices experience degraded service – and, in some cases, even an inability to connect to the LTE network – whereas Band 17 devices operate normally.[4]

The V-COMM Report reaches the opposite conclusion on the basis of test results purporting to show that, contrary to the other tests and analyses, Band 12 devices actually do not experience degraded performance until Channel 51 signal levels reach extremely high power levels of at least -12.5 dBm and often not until +5 dBm (depending on the device tested). These results are highly questionable on their face, because, in our experience, mobile devices typically experience significant degradation in performance well before interfering signals reach these extremely high power levels. And, further scrutiny of the V-COMM Report, as well as additional testing by 7Layers, confirms that V-COMM's results reflect flawed testing assumptions, parameters and methodologies. After correcting the two most obvious errors, the testing approach used by V-COMM confirms that Band 12 devices experience degraded performance when Channel 51 signal levels are in the -40 dBm to -30 dBm range.

The first error in V-COMM's Channel 51 test is that it appears to use relatively high LTE signal levels that are experienced away from the cell-edge and closer to cell towers (*i.e.,* the eNodeBs). This approach is like testing the potential for hurricane damage by focusing on inland locations rather than waterfront locations. The higher LTE signal levels near the LTE eNodeB are better able to overcome interference from Channel 51. In the real world, however, LTE signal levels vary considerably, with much weaker LTE signals existing closer to the cell edge, at indoor locations, in valleys, behind structures, and at other locations. It is in these areas where LTE signals levels may not be able to overcome interference from Channel 51, and thus it is critical that any testing for Channel 51 interference focus on these "worst case" scenarios. Customers expect to be able use their mobile broadband service (and obtain good performance) in all locations, not only in close and unobstructed proximity to the eNodeB.

The second error in V-COMM's Channel 51 tests is that it allocates to the test devices a very high number of physical resource blocks ("PRBs") for the uplink and downlink. The number of PRBs allocated to a device is dynamically set by the eNodeB, and can change as fast as every millisecond. It is often the case that only a few PRBs are allocated to a device in the cell at any given time. For example, at times when there are ten devices conducting a data session within

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[3] *See, e.g.,* V-COMM Report, Figures 5-6, 9-11. R-T 7/16 Paper, at 8-13 (describing tests and analyses by Qualcomm, PCTEST and 7Layers).

[4] *See, e.g.,* R-T 7/16 Paper, at 8-13 (describing tests and analyses by Qualcomm, PCTEST and 7Layers).

a cell at the same time, at least some of the devices will necessarily be allocated five or fewer PRBs. V-COMM's tests, however, allocate almost half of the uplink PRBs available in the cell (*i.e.*, 24 PRBs out of 50 PRBs for the channel bandwidth of 10 MHz) to the tested device, and they allocate all of the 50 available downlink PRBs to the tested device. By assigning the test device so many PRBs, V-COMM fails to account for the fact that effective Channel 51 interference is greater when fewer PRBs are allocated to the uplink and downlink.

For the uplink, the transmit power of a device is distributed among the PRBs it is allocated, which results in greater power spectral density when fewer PRBs are allocated to the device, increasing the potential for reverse intermodulation interference from Channel 51 signals. Similarly, for the downlink, when a device is allocated all 50 PRBs, it is relatively less susceptible to interference because the resource blocks that are less subject to interference would facilitate the correct retrieval of the downlink packet.

7Layers conducted testing that mimics V-COMM's tests – *i.e.*, similar testing equipment and configuration from the same equipment manufacturer and the same LTE channel center frequency (710 MHz) – but makes more realistic assumptions about the LTE signal level and PRB allocations. These tests confirm that the errors identified above are largely responsible for V-COMM's highly questionable results. These tests show that when realistic LTE power levels are used, and when a realistic number of PRBs is allocated to the uplink and downlink, Band 12 devices experience degraded performance when the Channel 51 signal level reaches about -34 dBm.

In addition to its flawed lab testing, V-COMM also conducted field tests in Waterloo, Iowa that purport to measure throughput levels and Block Error Rates ("BLER") for a Band 12 device (operating on a 10 MHz LTE channel bandwidth using the B and C blocks) in an area "near" a Channel 51 transmitter. V-COMM claims that these tests show that the Band 12 device used in its test experienced no significant reduction in throughput or BLER.

There are several problems with this test. *First*, V-COMM's field tests were conducted mainly in areas quite far from the Channel 51 transmitter where Channel 51 signal levels were well below the -40 dBm to -20 dBm range where testing has found interference to occur. *Second*, the throughput and BLER readings reported by V-COMM are meaningless. For throughput, V-COMM compared a 5 MHz LTE deployment to a 10 MHz LTE deployment. A 10 MHz LTE deployment, absent interference, will more than double the throughput of a 5 MHz deployment (due to the higher spectral efficiency resulting from the greater bandwidth). It is impossible to ascertain from V-COMM's throughput comparisons the extent to which throughput increased in the 10 MHz LTE deployment compared to the 5 MHz LTE deployment, making it correspondingly impossible to determine with any precision the impact of Channel 51 interference on throughput. V-COMM's BLER measurements are also meaningless. LTE networks are designed to achieve a 10% BLER, and will do so in ways that may reduce throughput.[5] Thus, field test results showing that a Band 12 device achieved a 10% BLER reveal nothing about actual performance of the device in terms of throughput. *Third*, V-COMM's field tests, like its lab tests, do not examine the worst-case interference scenario. V-COMM's field tests used a Band 12 device (a "MiFi" device) that its own testing showed to be less prone to interference, rather than the Band 12 smartphone that its own testing showed to be much more prone to interference.

E-Block Interference. V-COMM agrees that Band 12 devices are susceptible to two forms of interference from E block transmissions: (1) adjacent channel interference ("ACI") and (2) intermodulation interference. According to Qualcomm's analyses of the 3GPP specifications, commercial Band 12 filter specifications, and device desensitization calculations, Band 12 devices begin to experience degradation in performance when E block signal levels reach about -50 dBm (whereas Band 17 devices are immune from such interference for any relevant E block signal levels). Qualcomm also presented the actual signal strength measurements from its D block mobile video network (MediaFLO), which has propagation characteristics nearly identical to the E block, showing that D block signal levels in large geographic areas, including downtown areas, were often well above -50 dBm.

V-COMM purports to show that the Band 12 devices it tested did not experience significant degradation in performance until E block signal levels reach much higher levels, closer to -25 dBm, and that real world E block deployments will produce such signal levels in only small geographic areas. The foundation underlying V-COMM's argument is that the devices it tested were engineered to be more resistant to E-block interference than required by the governing 3GPP standards. Even if that were true (as we explain below, V-COMM's test results are highly questionable), such results are largely irrelevant here. The mere fact that the handful of Band 12 devices tested by V-COMM (which included only one smartphone) may be engineered to be more resistant to E Block interference than required by the 3GPP standard is not a basis for assuming that *all current and future* Band 12 devices would be (or could be) engineered to be more resistant. If the Commission were to adopt an interoperability mandate based on V-COMM's testing, it would essentially be requiring all future handset makers to adopt specifications that far exceed those required by 3GPP specifications, which would likely require significant performance and/or cost trade-offs.

In any event, V-COMM's test results are unreliable, for many of the same reasons that its Channel 51 tests are unreliable. Again, V-COMM does not disclose the LTE signal levels used in its lab tests, and as discussed above, it appears that V-COMM's testing used high LTE signal levels that can better overcome E block interference, rather than the much lower LTE signal

[5] Mobile devices report the Channel Quality Indicators (CQIs) to the eNodeB so that the downlink instantaneous BLER of 10% (or less) can be achieved by choosing appropriate transmission parameters such as the modulation scheme and the amount of channel coding. A lower overall packet error rate such as 1% can be achieved through retransmissions at various layers of the air interface protocol stack.

levels that actual users will commonly experience in the real world. And, again, V-COMM allocated half of the available PRBs to the uplink and all of the available PRBs to the downlink, which, as noted, reduces the intensity and the impact of interference. V-COMM's test configuration also includes two filters with unspecified characteristics (a "UE receive" filter and an "E block" filter). It is quite possible that these filters reduced the amount of interference that actually reached the test device. For all of these reasons, V-COMM's finding that Band 12 devices do not experience interference until E block signals reach about -25 dBm is not reliable.

There are also significant problems with V-COMM's modeling of E Block signal levels. V-COMM used a TM 91-1 propagation model for its analyses, which is a highly simplistic model. But this model is not designed for transmitter heights of more than 300 feet, and we understand, based on discussions with Qualcomm related to its MediaFLO deployment, that many E block transmitters are likely to be placed at locations higher than 300 feet.[6] Moreover, this simplistic model fails to account for the fact that path loss is different for urban, suburban, and rural areas. Nor does it account for the fact that different frequencies have different path loss characteristics. V-COMM also uses questionable inputs. For example, it assumes that E block transmitters will often transmit at levels below the maximum allowable 50 kW, and V-COMM fails to identify the antenna pattern it used in the model.

In any case, even V-COMM's flawed results confirm that there will be large areas where Band 12 devices will experience significant degradation and Band 17 devices will not (although, as explained below, V-COMM's maps showing these areas understate the geographic scope of such areas). V-COMM argues that these instances can be addressed by collocating E block transmitters with LTE transmitters. As we have previously explained, it is often not feasible to do that, and in any event, such collocation will not fully address interference because E block transmissions extend far greater distances than LTE transmissions. V-COMM claims that Qualcomm's MediaFLO system transmitters were collocated with E block transmitters 98% of the time. But this analysis is based on an extrapolation of a sample of a few areas where MediaFLO transmitters were collocated with mobile broadband transmitters. Based on discussions with Qualcomm, we understand that about half of its MediaFLO transmitters were *not* collocated with mobile broadband transmitters, and that the proportion of collocations was even lower for its initial roll-out.

The remainder of this paper is divided into two sections. In Section 1, we provide a detailed analysis of V-COMM's Channel 51 interference testing. In Section 2, we provide a detailed analysis of V-COMM's E block interference testing.

1. CHANNEL 51 ANALYSIS

V-COMM used two approaches to analyze the relative impact of Channel 51 interference on Band 12 and Band 17 devices. In the first approach, V-COMM used wireless propagation

[6] In preparing our response to the V-COMM Report, we sought Qualcomm's input on V-Comm's assertions about technical aspects of Qualcomm's MediaFLO deployment.

models and Channel 51 field measurements to estimate Channel 51 signal levels in various geographic areas, and V-COMM conducted lab tests to determine whether these Channel 51 signal levels cause interference in Band 12 and Band 17 LTE devices. In the second approach, V-COMM worked with U.S. Cellular to conduct field tests in Waterloo, Iowa, where V-COMM intended to measure the performance of Band 12 devices in the presence of Channel 51 broadcasts. For the reasons set forth below, V-COMM's analyses under both of these approaches are fundamentally flawed and cannot be relied upon to draw any useful predictions about the comparative performance of Band 12 and Band 17 devices in the presence of real world Channel 51 signals.

1.1 V-COMM PROPAGATION MODELING, LAB TESTING, AND CHANNEL 51 FIELD MEASUREMENTS

V-COMM used propagation models and field testing to determine Channel 51 signal levels at ground level in areas surrounding Channel 51 transmitters. These analyses confirm that there are large areas surrounding Channel 51 transmitters, including urban areas, where Channel 51 signal levels are between -40 dBm and -20 dBm.[7] Multiple independent lab tests and other analyses have demonstrated that, at Channel 51 signal levels in this range, Band 12 devices experience degradation in service, and even an inability to connect to the LTE network, whereas Band 17 devices do not.[8] Thus, V-COMM's own Channel 51 field tests and propagation modeling confirm the wide prevalence of ground level Channel 51 signals that other multiple other tests have shown to be sufficiently high to cause significant degradation of performance for Band 12 devices, but not Band 17 devices.

V-COMM contends, however, that Band 12 devices are actually unaffected by Channel 51 signals until those signals reach about -12.5 dBm (for the smartphone used in its tests) and up to about +5 dBm (for the "dongle" used in its tests).[9] These conclusions on their face raise significant questions about the validity of V-COMM's tests. In our experience, all else being equal, mobile devices typically experience degradation in service well before interfering signal levels reach such extremely high power levels.

Moreover, V-COMM's test results are contrary to all of the other testing of Band 12 devices that we have seen. The PCTEST test results show that the Band 12 device it tested experienced degradation in performance when Channel 51 signal levels reached –34 dBm, and had difficulty even connecting to the mobile network at Channel 51 signal levels of –27 dBm. Similarly, 7Layers' tests showed that the Band 12 device it tested began to experience significant signal performance degradation when Channel 51 signal levels reached as low as –37 dBm.

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[7] V-COMM Report, at Figures 5-6 (reporting modeling results); 9-11 (reporting field test results).

[8] *See, e.g.,* R-T 7/16 Paper, at 8-13 (describing tests and analyses by Qualcomm, PCTEST and 7Layers).

[9] *See* V-COMM Report, at Figure 3.

Qualcomm's computations showed that Band 12 devices would begin to experience significant desensitization when Channel 51 signal levels reach about –30 dBm.[10] Moreover, all of these other tests confirmed that once Channel 51 signals began to interfere with a Band 12 device, the performance of the Band 12 device dropped precipitously for each additional 1 dB increase in interference levels. Indeed, the call is dropped within a few dBs of the Channel 51 signal level where the device was working just fine.[11]

The tests conducted by V-COMM, PCTEST and 7Layers all appear to have used similar testing equipment.[12] V-COMM's highly questionable outlier results are thus likely caused by its use of different assumptions and testing parameters than those used by PCTEST and 7Layers. Unfortunately, the V-COMM report omits critical assumptions and inputs that it relied upon, making it impossible to determine precisely from its report why its tests produced results that are so unlikely and that are such outliers from all previous tests. However, based on our prior and new analyses and further testing by 7Layers, we were able to identify two incorrect parameters likely used in the V-COMM tests that explain much of the discrepancy.

Before turning to those two parameters, however, we note that one of the most obvious differences between the V-COMM tests and those of PCTEST and 7Layers is that the V-COMM tests used a different center frequency. The lower 700 MHz B and C blocks span 12 MHz, from 704 MHz to 716 MHz. A 10 MHz LTE Band using the lower 700 MHz B and C blocks could thus be theoretically centered at 711 MHz (spanning 706-716 MHz), 710 (spanning 705-715 MHz), or 709 (spanning 704-714 MHz). The original testing conducted by 7Layers and PCTEST used a 711 MHz center channel, whereas the testing conducted by V-COMM used a 710 MHz center channel. Testing by 7Layers, however, confirms that changing the center channel used in its original tests to V-COMM's 710 MHz assumption has only a marginal impact on the results.[13]

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[10] Qualcomm Comments, at 41-42.

[11] The existence of real-world propagation effects such as shadow fading (with the typically used standard deviation of 8 dB) would make the Channel 51 interference even more precarious and unpredictable. The actual geographic areas affected by the Channel 51 interference would be much larger than the area predicted by a typical propagation model including a line of sight (LOS) model.

[12] All of these tests used Rhode and Schwartz ("R&S") equipment. We note that PCTEST and 7Layers used the R&S TS8980FTA NetOp (Automated), which is the state-of-the-art integrated system for device testing. V-COMM used a less expensive approach that manually combined the necessary R&S equipment and other pieces of equipment in a bench-top set-up. Although the integrated R&S system used by PCTEST and 7Layers likely produces more accurate results than the bench-top setup used by V-COMM, we have no reason to believe that any such difference would account for the wide discrepancy of the results observed by V-COMM.

[13] *See* Exhibit A (7Layers Test Results).

Thus, we now turn to the two parameters that do appear to explain V-COMM's questionable results.

1.1.1. LTE Signal Levels. Choosing a proper LTE signal level for lab tests when assessing the potential for interference is critical. The most important factor affecting the performance of a mobile network and a device – that is, the efficiency and speed at which devices can receive and send transmissions – is the relative strength of the desired signal (here, the LTE signal) compared to the interfering signal (here, the Channel 51 signal).[14] Wireless engineers refer to this critical factor as the signal-to-interference ratio (SIR).[15] The greater the SIR, the better the device will perform.[16] Thus, all else being equal, the use of greater LTE signals in lab tests will result in higher SIRs, which in turn will cause the tested device to perform better at any given Channel 51 interference signal level.[17] In other words, where interfering signal levels are high, a device may still perform well if the LTE signal level is sufficiently high.

In the real world, LTE signal levels vary dramatically throughout a cell, depending on a number of factors. One factor is how far the handset is from the LTE cell site (*i.e.,* the "eNodeB"). The farther the handset is from the eNodeB, the lower the received LTE signal level. In addition, LTE signal levels will be lower at indoor locations, in areas where there are dips in the terrain, and in areas where the LTE signal is blocked by natural or man-made structures.

When conducting lab tests of LTE devices, it is necessary to choose LTE signal levels that will be transmitted to the device, not in the best, good or even average conditions (*e.g.* when the device is located near an eNodeB), but under typical worst-case conditions (*e.g.,* when the device is closer to the cell edge or at an indoor location). Where interference from another source degrades the performance of a device near the cell edge, at indoor locations, or other areas with relatively weak LTE signals, such interference could have a very substantial impact on overall network performance and the experience of many customers.[18] Customers expect to be able to use their devices and obtain high quality service everywhere in the cell, including in areas where LTE signal levels may be weaker, and network operators design their networks to ensure minimum service quality levels even at the cell edge.

Commercial cellular networks aim for very high performance metrics such as 98% retainability (*i.e.*, no more than 2 out of 100 calls should experience a drop). Most call (or data connection) drops occur closer to the cell edge or at other areas where LTE signals are weaker relative to

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[14] R-T 6/1 Paper, at 5-8.

[15] *Id.*

[16] *Id.*

[17] *Id.*

[18] *Id.*

interference. Hence, from the standpoint of network design, it is critical to assess the impact of interference in these areas with weaker LTE signals.

To determine the LTE signal levels that correspond to areas nearer to the cell edge, lab tests typically begin by determining the "reference sensitivity" for the device, which is the lowest LTE signal level at which the device can still achieve 95% throughput levels, as per 3GPP specifications.[19] These are the LTE signal levels that can be viewed as representative of the worst-case interference scenario within an LTE cell – these are the signal levels that exist at the cell edge and other locations where LTE signals are weakest.

The next step is to determine the extent to which the test should evaluate the LTE signal levels above the reference sensitivity. The original tests conducted by 7Layers and PCTEST evaluated the impact of Channel 51 interference using LTE signal levels at 3 dB above the reference sensitivity for the device, which represents LTE signal levels between the cell edge and the midpoint of the cell, and is somewhat conservative (*i.e.*, corresponding to an interference scenario better than the worst-case interference scenario). The actual worst-case interference would correspond to the LTE signal levels of reference sensitivity. As noted, these tests confirmed that, at LTE signal levels of reference sensitivity plus 3dB, Band 12 devices began experiencing significant degradation in performance at Channel 51 signal levels in the -40 dBm to -30 dBm range.

Unfortunately, V-COMM does not report the LTE signals it used in its tests. As discussed below, however, further testing by 7Layers demonstrates that, if V-COMM had used reasonable LTE levels (set either at reference sensitivity levels or reference sensitivity +3 dB) to reflect the cell-edge situations where interference plays a prominent role in determining the consumer experience, V-COMM's testing would have confirmed the results of the original PCTEST and 7Layers testing results. Indeed, 7Layer's testing shows that if V-COMM had used even an LTE signal level of reference sensitivity +6 dB, it still would have found significant interference at Channel 51 signal levels much lower than reported by its tests.

1.1.2. Physical Resource Block Allocations. The second assumption relied on by V-COMM that likely accounts for much of the discrepancy between its test results and the other test results we have reviewed relates to the number of physical resource blocks ("PRBs") allocated to the device for the uplink and the downlink. In a 10 MHz LTE deployment, each cell has 50 PRBs that can be allocated to the uplink and 50 PRBs that can be allocated to the downlink. These PRBs are shared among all of the devices active in the cell. The numbers of PRBs allocated to an uplink transmission and a downlink transmission are determined dynamically (as fast as every millisecond) by the eNodeB, depending on various factors, including, for example, the amount and priority of data waiting in the buffer of each device in the cell, the Quality of Service needed for the data transmission for each device in the cell, and prevailing downlink and uplink channel conditions. Thus, any given communication (to or from the device) may use a different number of PRBs at any given time, from 1 resource block up to 50 resource blocks.

[19] *See* 3GPP TS 36.104 specification.

The number of PRBs allocated to the uplink and the downlink in lab tests can have a significant impact on the Channel 51 interference testing results. For example, when the device is transmitting at a certain power level based on the uplink closed-loop power control, that power is distributed over the number of resource blocks used for the transmission. Therefore, when fewer PRBs are allocated to the uplink, this power is more concentrated. This increased concentration of power over fewer resource blocks can result in higher-powered reverse intermodulation products, causing greater interference to the device receivers.[20] Similarly, on the downlink, if the assigned PRBs are located in the part of the spectrum most affected by reverse intermodulation, the performance of the device will be degraded by more than if additional or different PRBs are allocated to the downlink.

When choosing the number of PRBs for lab tests, it is important to focus on allocations that will occur in the real world in which cells will often be active and congested. On the uplink side, the original tests conducted by PCTEST and 7Layers allocated 5 resource blocks to the uplink signal. This assumption is quite reasonable. For example, when 10 users in a cell engage in a data session simultaneously, the number of uplink PRBs allocated to some users at any given instant would necessarily be 5 (or fewer). Indeed, if the eNodeB consistently allocates more than 5 PRBs to some of those users, other users necessarily will be allocated fewer than 5 PRBs. On the downlink side, the original tests conducted by 7Layers examined both a 50 PRB allocation and a 16 PRB allocation. These tests showed that allocating 16 PRBs rather than 50 PRBs to the downlink significantly increased the potential for interference. These tests confirm that using fewer PRBs for the downlink increases the potential for interference from Channel 51.

By contrast, V-COMM's lab tests assume that the single tested device will be allocated nearly half of the available PRBs (24 PRBs) for the uplink and all 50 PRBs for the downlink. Although this scenario may occur in the real world at some locations and in some conditions at some times, it ignores the many instances where far fewer than 24 uplink and 50 downlink PRBs will be allocated to a device at any given time under many real world conditions. And when fewer resource blocks are allocated to the uplink and downlink, the impact of interference from Channel 51 signals is greater. As shown below, applying a more realistic PRB allocation than used in V-COMM's tests (and using reasonable LTE signal assumptions to reflect the cell-edge situations that are more prone to interference), 7Layers has confirmed that V-COMM would have obtained results similar to those obtained in the original PCTEST and 7Layers tests.

1.1.3. 7Layers Testing. AT&T commissioned 7Layers to determine the extent to which V-COMM's assumptions caused V-COMM's outlier results. The tests conducted by 7Layers

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[20] More specifically, the mobile device would be transmitting close to the maximum transmit power (*i.e.*, 23 dBm). The tests mimic the cell-edge conditions for the purpose of evaluating the impact of Channel 51 interference. By spreading that +23 dBm over only 5 PRB, rather than 24 PRBs, the power spectral density (power per hertz) will significantly increase by 6.8 dB. Furthermore, the power of the third-order intermodulation product also increases by more than the power spectral density of the device's transmission.

replicate the tests conducted by V-COMM for a 10 MHz LTE network centered at 710 MHz for the uplink and 740 MHz for the downlink, with two exceptions. First, given that V-COMM does not report the LTE signal level it used in its tests, 7Layers examined three different reasonable LTE signal levels: (1) reference sensitivity; (2) reference sensitivity +3 dB; and (3) reference sensitivity +6 dB. Second, whereas V-COMM assumed that the test device would be allocated nearly half of the available uplink PRBs and all of the available downlink PRBs, 7Layers allocated more reasonable 5 PRBs to the uplink and 16 PRBs to the downlink. The assumptions, parameters, and results of these tests are shown in the 7Layer testing report, attached hereto as Exhibit A.

These results confirm that when LTE signal levels were set at the reference sensitivity levels and a more reasonable number of PRBs were allocated to the uplink and downlink, the Band 12 device operated well below the 95 percent throughput specified by 3GPP when Channel 51 signal levels were -50 dBm (the lowest Channel 51 signal used in the 7Layers test). In other words, these tests confirm that where Channel 51 signal levels are as low as -50 dBm, Band 12 LTE devices would begin to experience performance degradation at the cell edge and other locations within the cell where LTE signals tend to be very low.

The 7Layers results further confirm that when LTE signal levels are increased to 3 dB *above* the reference sensitivity level, the Band 12 device operated below the 95 percent throughput specified by 3GPP when Channel 51 signal levels reached -34 dBm. In other words, this test confirms that even in areas farther from the cell edge, Band 12 devices will experience significant degradation in performance in the presence of Channel 51 signal levels as low as -34 dBm.

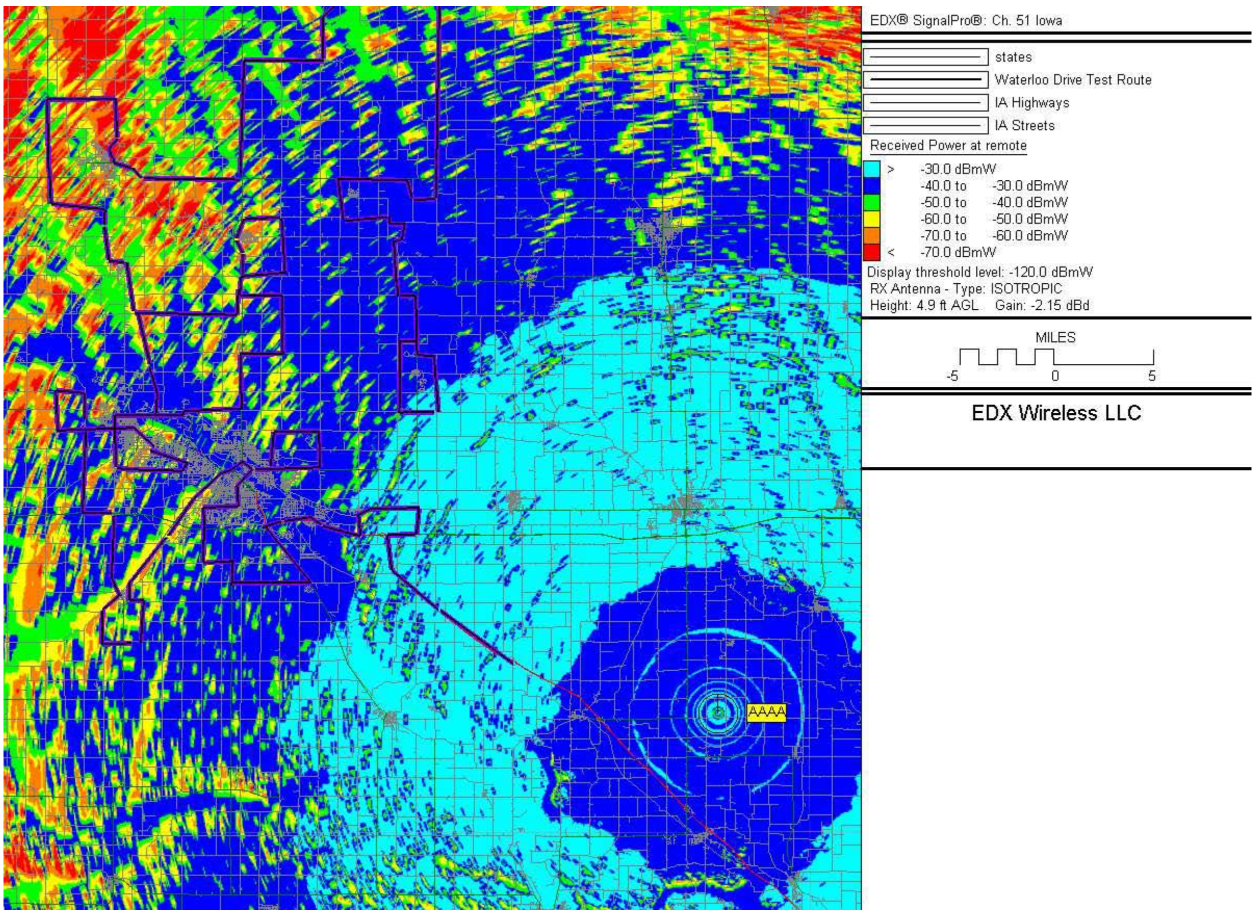
The 7Layers results also confirm that when LTE signal levels are increased to +6 dB *above* the reference sensitivity level, the Band 12 device operated below the 95 percent throughput specified by 3GPP when Channel 51 signal levels reached -29 dBm. This test confirms that even in areas quite far from the cell edge and relatively close to the eNodeB, Band 12 devices will experience significant degradation in performance in the presence of Channel 51 signal levels as low as -29 dBm.

These 7Layers tests confirm that V-COMM's testing results are driven largely by faulty assumptions regarding LTE levels and PRB allocations. For this reason, it is our view that V-COMM's lab tests cannot be relied upon to draw any conclusions about the Channel 51 signal levels that will degrade performance for Band 12 devices in many likely real world scenarios.

1.2 V-COMM's Waterloo Field Tests

V-COMM contends that it tested the impact of Channel 51 interference on Band 12 devices on U.S. Cellular's network in Waterloo, IA, first on a 5 MHz LTE deployment using B block spectrum (where Channel 51 reverse intermodulation interference would not likely occur), then on a 10 MHz LTE deployment using B and C block spectrum (where channel 51 reverse intermodulation products would occur). V-COMM contends that it found no difference in performance, and it thus concludes that Band 12 devices operating on networks using the B and C blocks do not experience significant performance degradation in the presence of Channel 51 signals. These tests are fundamentally flawed in multiple respects.

1.2.1. Flawed Sampling. These field tests were conducted in and around Waterloo, Iowa, which is located about 30 miles away from the nearest Channel 51 transmitter. The drive test map in the V-COMM report shows that the vast majority of the test points were more than 30 miles from the Channel 51 transmitter and that some of the testing occurred 50 or more miles from the transmitter. The Figure below is copied from the V-COMM report (Figure 18), and shows V-Comm's drive test routes and the predicted Channel 51 signal levels in these areas.



As V-COMM's own map confirms, it is unlikely that Channel 51 signal levels in the areas of Waterloo it tested were at the levels that have been shown to cause degradation in performance for Band 12 devices, *i.e.,* in the -40 dBm to -30 dBm range (and greater than -30 dBm). The propagation modeling reported by V-COMM predicts that Channel 51 signal levels in the area tested are typically in the sub -70 dBm to -40 dBm range. In other words, the testing was done in areas with Channel 51 signal levels that are typically below those that caused significant degradation in performance in the realistic lab tests conducted by PCTEST and 7Layers. There appear to be only a limited number of measurements in locations with Channel 51 signal levels likely to be above -40 dBm. Because V-COMM reports only the overall average of the field test readings, any poor performance measured in these areas would certainly be masked by the large number of test points in areas where Channel 51 signal levels were well below -40 dBm.

1.2.2. Flawed Reliance On Throughput & BLER Measurements. V-COMM relies on throughput and Block Error Rate ("BLER") statistics to assess the impact of Channel 51 interference on Band 12 and Band 17 devices. V-COMM concludes that moving from a 5 MHz deployment using only B block spectrum to a 10 MHz deployment using both B and C block spectrum does not show any performance degradation according to these metrics, thus indicating a lack of interference from Channel 51. But these metrics, as used in the V-COMM report, are meaningless, and the conclusions are misleading.

As to throughput, it is well established that 10 MHz LTE deployments (*e.g.*, combined B and C blocks) are more efficient than 5 MHz LTE deployments (*e.g.*, B block only), and thus that throughput available in a 10 MHz LTE deployment will not be just double the throughput of a 5 MHz LTE deployment (because double the amount of spectrum is deployed), but will be *more* than double. But it is impossible to determine from V-COMM's rough throughput distribution comparisons the extent to which throughput increased in the 10 MHz LTE deployment compared to the 5 MHz LTE deployment, making it impossible to ascertain how much degradation in throughput was caused by Channel 51 interference. The throughput measurements reported by V-COMM are meaningless, because any difference in throughput levels between the 5 MHz and 10 MHz LTE deployments reflects the *net impact* of increased throughput due to greater efficiency and degraded throughput due to interference.

The BLER measurements reported by V-COMM are likewise meaningless. LTE networks are designed to achieve a 10% BLER by adjusting modulation schemes, MIMO, retransmissions of packets, and so on in a manner that produces reduced throughput in exchange for the target BLER (*i.e.*, 10%). For example, to achieve a 10% BLER in areas of high interference, the LTE network may use a QPSK modulation scheme rather than a more efficient (*i.e.,* higher throughput) 16-QAM modulation scheme, because the QPSK modulation scheme can achieve a given target BLER in areas of higher interference. The LTE network may also forgo the use of MIMO (which provides higher throughput) to maintain BLER in areas where interference is high. The fact that field tests showed that a Band 12 device achieved the same BLER measurement for the 5 MHz deployment and the 10 MHz deployment says nothing about actual performance of the device in terms of throughput. BLER can only be used as a proxy for throughput in lab tests where the modulation schemes, MIMO, and other factors are held constant.

1.2.3. Choice of Drive Test Device. The V-COMM Report raise significant questions as to whether the testing was conducted in an objective manner. For example, V-COMM's Channel 51 lab testing included three Band 12 devices: (1) a smartphone, (2) MiFi device, and (3) dongle. In the lab tests, the Band 12 smartphone performed the worst and the Band 12 MiFi device and dongle performed much better. An objective test seeking to estimate the impact of forcing AT&T to switch from Band 17 to Band 12 therefore would have used the smartphone, especially given that the vast majority of mobile broadband users are smartphone users and given that the standard industry practice is to focus on the more hostile interference environment (as opposed to less hostile interference environment). Instead, however, for reasons that V-COMM does not explain, it used the MiFi device in its Waterloo drive tests. That is, it used a device that it had already determined was less prone to Channel 51 interference than the smartphone, thus further mitigating the impact of the Channel 51 interference in the Waterloo tests.

V-COMM should have chosen the Band 12 smartphone as the test device. V-COMM should have carried out tests in the areas where Channel 51 signals were strong, and it should have reported throughput in interference-prone areas to get a more accurate view of the impact of Channel 51 interference.

We also find it curious that V-COMM chose to rely on propagation modeling, rather than actual field test measurements of Channel 51 signal levels in these areas, especially given that V-COMM reported actual Channel 51 signal levels in Cedar Rapids near the Channel 51 tower. If V-COMM conducted field test measurements of Channel 51 signal levels in Cedar Rapids, it presumably did conduct (or at least could have conducted) similar measurements for Waterloo.

2. E BLOCK ANALYSIS

The E block frequencies are located immediately adjacent to the receive frequencies used by Band 12 devices, but are separated by 6 MHz from the receive frequencies of Band 17 devices. Because the frequency range used by Band 12 devices is immediately adjacent to the E Block, the RF filters used in Band 12 devices cannot effectively filter energy from E block transmissions. By contrast, Band 17 devices, which have 6 MHz of separation from the E block frequencies, can more effectively filter energy from E block transmissions. As a result, Band 12 devices are necessarily far more susceptible to E block interference than Band 17 devices.

V-COMM's lab testing confirms these facts. Its lab tests show that Band 12 devices experience degradation in performance (which V-COMM measured in terms of desensitization) in the presence of much lower E block signal levels than Band 17 devices.[21] For example, in Figure 24, V-COMM reports lab tests confirming that, in a 10 MHz LTE deployment using the B and C blocks, all of the Band 12 devices began experiencing desensitization at much lower (*e.g.*, about 10 dB weaker) E block signal levels than Band 17 devices. V-COMM's report shows similar trends for a 5 MHz LTE deployment using the C block, and for a 5 MHz LTE deployment using B block.[22]

[21] *See* V-COMM Report, ¶¶ 64-65 & Figures 19-24.

[22] V-COMM's lab test results for the 5 MHz LTE deployment using B block contain one anomaly in which one of the Band 17 devices apparently experienced more desensitization than some Band 12 devices at certain E block power levels. V-COMM never explains this anomaly, and, in any event, this scenario is less relevant to the real world, where a minority of LTE deployments are B block-only deployments.

V-COMM argues that although Band 12 devices are far more susceptible to interference than Band 17 devices, the absolute E block signal levels at which such interference will occur are very high, exist in only small geographic areas, and can be addressed through various network engineering strategies. These assertions, however, are based on inappropriate parameter assumptions, and multiple incorrect assumptions relating to the effectiveness of network design in addressing the types of interference concerns at issue.

2.1. V-COMM's E Block Lab Testing

V-COMM conducted lab testing that included three Band 12 devices (a smartphone, a MiFi device, and a dongle) and four Band 17 devices (three smartphones and a dongle). V-COMM correctly recognizes that E block transmissions interfere with Band 12 and Band 17 devices in two ways. First, there is "Adjacent Channel Blocking," which refers to the fact that power from the E block transmissions will enter the lower A, B, and C receive blocks and thus interfere with the device's ability to receive the desired LTE signal. Second, there is "Intermodulation Interference," which refers to circumstances where the E block transmission enters the device's duplexer, mixes with the device's transmit signal, and creates intermodulation products that fall within the device's receive bands and thus interfere with the device's ability to receive the desired LTE signal.

V-COMM thus designed tests in an attempt to determine the E block signal levels at which the Band 12 and Band 17 devices would begin to experience desensitization as a result of Adjacent Channel Blocking and Intermodulation Interference. According to these tests, in a 10 MHz LTE deployment using the B and C blocks, Band 12 devices do not begin to experience desensitization until E Block signal levels reach about -25 dBm (depending on the device), and Band 17 devices do not begin to experience desensitization until E Block signal levels reach between -17 dBm and -11 dBm. Although these tests correctly confirm that Band 12 devices are far more susceptible to interference, the absolute levels of E block signals required to cause desensitization appear to be overstated.

Qualcomm has demonstrated that, according to 3GPP specifications and the specifications of commercial filters used in Band 12 and Band 17 devices, Band 12 devices operating in a 10 MHz LTE deployment in the B and C blocks would experience 3 dB of desensitization from Adjacent Channel Blocking with a -48.5 dBm E block signal, and 6 dB of desensitization with a -43.7 dBm E block signal. Qualcomm found no (or virtually no) desensitization for Band 17 devices at these levels. Qualcomm further demonstrated that this Adjacent Channel Blocking would be compounded by the Intermodulation Interference from the E block.[23]

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[23] To analyze the E block related intermodulation interference, Qualcomm carried out simulation-based analysis using the filter specifications of top-tier commercial filters and the simulation tool that it uses to design the commercial chipsets. These simulation results show that E block signal levels as weak as -34.5 dBm at the device antenna cause 3 dB desensitization due to E block Intermodulation Interference. *See* Qualcomm Comments, at 23.

Based on Qualcomm's analysis, V-COMM's tests indicate that the LTE devices it tested are engineered to exceed 3GPP specifications in a manner that makes them far more resistant to E block interference. However, even if this were true, that does not establish a basis for an interoperability mandate that assumes that *all current and all future* Band 12 devices would be (or could be) engineered to be more resistant. If the Commission were to adopt an interoperability mandate based on V-COMM's testing, it would essentially be requiring all future handset makers to adopt specifications that far exceed those required by 3GPP specifications, which could severely limit the ability of device makers to develop and deploy next generation technologies in the desired form factors. The mandate would also limit the flexibility of the chipset and the device vendors in balancing the tradeoffs among the cost, the speed, the power, the size, and other factors.

In any case, V-COMM's testing has several flaws.

First, as with its Channel 51 testing, V-COMM fails to identify the LTE signal levels used in the tests. As we explained above, it is quite likely that V-COMM used LTE signal levels that tend to occur closer to the eNodeB, and failed to examine LTE signal levels that typically occur near the cell edge, at indoor locations, and in other areas where LTE signal levels are lower. As discussed above, when LTE signal levels are lower, devices necessarily experience degraded service at relatively lower interfering signal levels. By using high LTE signal levels that are non-reflective of the worst-case, real-world interference in its E block testing, V-COMM's tests correspondingly overstated the E block signal levels required to degrade the performance of Band 12 devices.

Second, as with its Channel 51 testing, V-COMM allocated nearly half of the available PRBs to the tested devices for uplink transmissions and all of the available PRBs to the downlink transmissions. As we explained above, the number of PRBs allocated to a device in the real world will often be much lower. When fewer PRBs are allocated to the uplink the power spectral density of the signal increases, which in turn increases the level of the interfering intermodulation signal. And, when fewer PRBs are allocated to the downlink, the device is less able to cope with interference. Thus, here again, V-COMM's use of relatively high PRBs for the uplink and downlink severely understates the potential for interference.

Third, as shown in Figure 41 (page 60) of the V-COMM Report, the test configuration included a device labeled "E-Block Filter." Presumably, this filter was used to ensure that the E block signal generated by the SFE-100 device was within the desired frequency ranges. But the use of this filter could have had additional effects that contributed to V-COMM's unexpected results. Most significantly, it is our understanding that these types of filters often attenuate the E block signal, and filter out of band emissions that may exist in the real world. It is impossible to determine the extent to which V-COMM's unidentified E block filter might have distorted V-

COMM's test results, because V-COMM's report does not provide any information about the specifications of this filter.[24]

Fourth, V-COMM fails to explain how it measured the impact of E block interference (and Channel 51 interference) on Band 12 and Band 17 devices. V-COMM purports to report "desensitization" estimates, but it never explains how it derived those estimates. There are different ways to compute desensitization, and V-COMM's failure to identify the approach it used makes it impossible to determine whether it used a valid approach and whether it properly computed desensitization under whatever approach it did use.

2.2 V-COMM's Analysis Of The Real World Impact Of E Block Interference

Using the inflated E block signal levels that, according to its lab tests cause degradation in device performance, V-COMM attempted to determine the geographic areas where E block signals are likely to be at levels that degrade the performance of Band 12 devices. V-COMM used propagation analyses for this task.

V-COMM argues that under the FCC's rules real-world E block transmissions will be less than 50 KW, and it uses a "TM 91-1" model to predict the signal level that can exist on the ground (or at the device antenna) under these rules.[25] The results were then overlaid onto maps with hypothetical E block sites that purportedly show no significant difference in the geographic areas where Band 12 and Band 17 devices will experience degraded performance.[26]

There are several significant problems with V-COMM's use and application of the TM 91-1 model that render its results unreliable here. But first, it is important to recognize that the way these results are presented in the V-COMM report is highly misleading. V-COMM used the TM 91-1 model to estimate the difference in geographic areas where, according to V-COMM's lab tests, Band 12 devices would experience degraded performance from E block transmissions, but Band 17 devices would not. V-COMM used the TM 91-1 model to make these comparisons for (1) a 5 MHz LTE deployment using only B block; (2) a 5 MHz LTE deployment using only C block and (3) a 10 MHz LTE deployment using both the B and C blocks.

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[24] V-COMM also used an unidentified "UE Receive Filter" in its tests, through which both the LTE signal and the E block signal passed before being measured by the spectrum analyzer. Here too, this piece of equipment could easily have attenuated the E block signal, thus artificially requiring a higher initial transmission to record interference. This filter was also used in the Channel 51 interference tests. Again, V-COMM's report does not include any specifications of this filter.

[25] *See* V-COMM Report, at 37-41, 61-62 (showing how these calculations were done).

[26] *See* V-COMM Report, at 42-44 and 64-69.

V-COMM focuses its discussion on the B block only deployment, and provides several maps showing that, based on V-COMM's analysis of a B-block deployment, the geographic areas where Band 12 and Band 17 devices are affected by E block signals are about the same. This presentation is misleading, however, because it omits the fact that for 5 MHz LTE deployments using C block, and for 10 MHz LTE deployments using the B and C blocks, there are much larger geographic areas where only Band 12 devices (not Band 17 devices) are adversely affected by E block interference.[27]

In any case, V-COMM's reliance upon and implementation of the TM 91-1 propagation model is likely to substantially understate the areas where Band 12 devices, but not Band 17 devices, will experience degraded performance from E block transmissions, for multiple reasons.

The TM 91-1 model is a highly simplistic model developed more than 20 years ago as a way to estimate signal path loss for distances of less than one mile and antenna heights of up to 300 feet. The model was developed by using a small sample of real world signal measurements that were available when the test was developed. The TM 91-1 is essentially a formula computed by fitting a line to the path loss measurements observed in that sample.

This simplistic model does not account for numerous important factors that affect path loss. For example, the model predicts the same path loss for transmitters located in a dense urban area surrounded by tall steel buildings as it does for a transmitter located in a rural area surrounded by low farmland. The TM 91-1 model also incorrectly assumes that higher and lower frequencies incur the same path loss.

The industry uses far more sophisticated and accurate models for measuring path loss over shorter distances. For example, the Okumura-Hata and COST-231 models (and their variations) are far more complete and widely used in the industry. These models consider the impact of many factors, including for example, the geographic morphology (*i.e.*, urban, suburban, and rural). With suitable adaptations, these models can be valid for a wide range of frequencies and distances. Furthermore, commercial network planning and design tools use real-world measurements to tune the baseline propagation models derived from Okumura-Hata and COST-231 models.

These more sophisticated models confirm that the TM 91-1 model's simplistic assumptions greatly miscalculate the path loss. As just one example, the Okumura-Hata model uses a frequency-dependent path loss term equal to $26.16*\log10(f_c)$, where f_c is the carrier frequency in MHz. The difference in path loss between 218 MHz and 850 MHz is $26.16*\log(850/218) = 15$ dB, which is quite significant. The TM 91-1 model, however, assumes that the path loss would be the same for these frequencies.

We also find E block signal level variations in Figures 25 to 27 to be unusual, because no random fading is assumed by the TM 91-1 model. In fact, Figure 2 in the TM 91-1 report shows

[27] *See* V-Comm Report, Figures 25, 27.

a straight line for the field strength. V-COMM also applied some antenna pattern to the TM 91-1 model (in addition to the translation between the TM 91-1 field strength and RSSI), but this antenna pattern is not defined, preventing third-parties from verifying the V-COMM analysis.

In any event, the TM 91-1 model was not designed to measure path loss for mobile broadcast networks, like the ones that are apparently planned for E block spectrum. The TM 91-1 model is designed to be accurate only for transmitters of up to 300 feet. But we understand from Qualcomm that, in its MediaFLO deployment, many of its transmitters were located far higher than 300 feet.

Moreover, it appears that the assumptions used by V-COMM when applying the TM 91-1 model understate actual signal levels. According to V-COMM, it assumed that some or all of the transmitters would broadcast at signal levels of less than the maximum authorized 50 kW, to meet certain Federal Communications Commission requirements. But, we understand from Qualcomm that these limitations did not limit Qualcomm's signal levels for its MediaFLO system to levels significantly below 50 kW in the vast majority of cases.

In any event, there is no need to rely on these propagation estimates. Qualcomm has submitted real-world D block (*i.e.*, MediaFLO) signal strength measurements. The D block and the E block are quite close in frequency and the D block measurements can be considered a reliable means to estimate the E block signal strength. In contrast, the V-COMM model is purely a theoretical exercise without any model tuning carried out to match the predicted signal strength with the actually measured signal strength.

2.3 V-COMM's Assertions That Interference From E block Transmissions Can Easily Be Mitigated Through Collocation

We find no merit to V-COMM's assertion that if a Band 12 eNodeB is "located on a structure close to the E-Block tower, the potential for interference could be eliminated."[28] It is true that collocating an eNodeB with an E block transmitter may increase the signal to noise ratio ("SIR") in some areas and thus reduce the impact of E block interference. But E block transmitters are designed to transmit 50 kW signals over many square miles, whereas eNodeBs are designed to transmit tens of watts over much smaller areas. As a result, simply collocating an eNodeB on the same tower as an E block transmitter may increase the SIR in some areas around the tower, but there will remain large areas beyond the tower where collocation at the eNodeB will have little or no impact on the SIR.

In fact, collocating an eNodeB on the same tower or structure as the E block transmitter will typically have little impact in the geographic areas most affected by E block transmissions. As V-COMM correctly points out, E block transmitters are typically pointed horizontally to increase the overall distance covered by the transmitter. As a result, E block signal levels may often be greater a certain distance away from the transmitter than they are nearby the transmitter.

[28] V-COMM Report, at 45.

Consequently, collocating an eNodeB with the transmitter will have little impact in the geographic areas where the E block signal is greatest, because eNodeBs are typically optimized (by down tilting and other measures) to maximize signal levels in the local region to minimize inter cell interference and maximize SIR. This mismatch in the areas where the E block and eNodeB signal levels are concentrated means that collocation would not improve SIRs in many geographic areas. To truly match RF coverage to maximize SIR for LTE, multiple eNodeBs would have to be located in areas surrounding the E block transmitters. Furthermore, one E block transmitter may cover an area that is covered by numerous base stations (*e.g.*, tens of base stations).

It is thus not practical to address E block interference through collocation and by adding cell sites in additional locations.[29] RF network planning and design, which is a non-trivial matter, and complete network retuning would need to be done for each newly added E block site. RF design modification is an iterative process. Implementation of the modified RF design would consume significant resources. In many instances, it may not be possible to place an eNodeB in a location that can ameliorate E block interference. It is our understanding that MediaFLO was not deployed overnight. As the E block video system is launched and its footprint is gradually expanded, the cellular networks would see an ever-changing interference environment, requiring immense human and non-human resources to tune LTE performance. It is also our understanding that the broadcast system would need to be tweaked or optimized after the launch. As additional E block transmitters are deployed to optimize the video broadcast subscriber's experience, the cellular networks would need to be optimized as well. In summary, until the E block video broadcast system is fully launched and optimized, the RF engineers of the cellular networks would have a moving target to mitigate interference and resolve customer complaints in case of a Band 12 mandate.

V-COMM's response is that transmitters used in Qualcomm's MediaFLO network were almost always collocated with a mobile broadband transmitter. As noted, even if true, that would not solve the interference problem. In any event, V-COMM's assertion is incorrect. V-COMM purports to have sampled a few of Qualcomm's legacy transmitters and notes that in the locations it sampled, there was also a mobile broadband transmitter. Based on these data, V-COMM extrapolates that mobile broadband transmitters were collocated at more than 90 percent of Qualcomm's MediaFLO transmitter locations. V-COMM does not explain how it chose its sample, but we understand from Qualcomm that the sample V-COMM used is not at all representative, and that, in fact, only about half of Qualcomm's MediaFLO transmitters were collocated with mobile broadband transmitters.

When Qualcomm deployed its MediaFLO network in any given area, we understand that it first deployed to gain maximum coverage. Accordingly, it typically deployed only a handful of transmitters at very high locations (*e.g.*, hilltops and tall buildings). These are places where mobile broadband providers do not typically deploy transmitters, because doing so would tend

[29] R-T 6/1 Paper, at 16-17.

to cause interference with other mobile broadband transmitters. After Qualcomm's initial deployment, it deployed additional transmitters to fill coverage gaps. These transmitters were often placed at lower heights and were thus more likely to be collocated with mobile broadband transmitter. These are the transmitters that V-COMM appears to have chosen for its sample. But overall, we understand that only about half of the MediaFLO transmitters were collocated with mobile broadband transmitters.

EXHIBIT A

Test Report: Test Configuration for Evaluation of the Impact of Varying LTE Signal Levels on the Band 12 Device Performance in the Presence of Channel 51 Interference

Index

Administrative Data

Testing Laboratory

Company: 7Layers, Inc.
Address: 15 Musick
Irvine, CA 92618
USA
Phone: 949-716-6512

Project Data

Report ID: VUS_ATT_1201_02
Responsible for testing and report: George Liu
Receipt of EUT: 5/3/2012
Date of Test(s): 9/27/2012
Date of Report: 9/28/2012

Applicant Data

Company Name: AT&T Services Inc.
Contact Person: Scott Prather, Joe Marx
Address: 1120 20th St NW, Suite 1000
Washington, CA 20036
E-mail: sp9162@att.com, jm7322@att.com

Manufacturer Data / DUT description

Band 12 LTE Tablet (Commercially Available from U.S. Cellular)
OUT: 00170B01

Test Equipment

Rohde and Schwarz TS8980FTANetOp

Name_of_Device	Type	Serial_Number
Rubidium Frequency Standard	MFS	1
CMW-500	CMW-500	100752
SMU200A Vector Signal Generator	SMU200A	103935 (Model No: 1141.2005k02)
AMU200A 1	AMU200A	100378 (Model No: 1402.4090k02)
Power Supply	NGMO2	100400
SMF100A Signal Generator	SMF100A	101321 (Model No: 1167.0000k02)
SSCU1 Inband Switching and Signaling Condition Unit	ISSCU-2x2 IP12	101224
SSCU2 Wideband Switching and Signaling Condition Unit	WSSCU-2x2 IP02	100714
MSCU1- F1, F4, F7, F13, F127	WSSCU-2x2 IP02	100714
FSQ-26 Signal Analyzer	FSQ-26	200844/026
NRP-Z21 Average Power Sensor	NRP-Z21	102328
Trigger	GV150-34	100100247
CS-PSSU Power Supply	CS-PSSU	100305 (Model No: 1126.7497.02)
SFE100 Test Transmitter 1	SFE100 (1)	121047 (Model No: 2112.4100K02)
SFE100 Test Transmitter 2	SFE100 (2)	121048 (Model No: 2112.4100K02)
SSCU2 Wideband Switching and Signalling Condition	WSSCU-2x2 IP02	100715
SMU200A Vector Signal Generator	SMU200A	104374
OSP - Open switch & control platform	OSP120	100148
CMW 500	CMW-500	106578
CMW 500	CMW-500	113628 (1201.0002K50.113628.QL)
AMU200A 2	AMU200A	100560 (Model No:

		1402.4090K02)
MSCU2 - F3,F8,F14,F7,F20	OSP120	100148
MSCU3 - F56,FF24,225,T38,T40	OSP120	100148
AMU200A 1	AMU200A	100525 (Model No: 1402.4090k02)
NRP-Z21 Average Power Sensor	NRP-Z21	100538
AMU200A 1	AMU200A	100xxx (Model No: 1402.4090k02)

Summary

The testing was performed in accordance to test plan titled “Test Configuration for Evaluation of the Impact of Varying LTE Signal Levels on the Band 12 Device Performance in the Presence of Channel 51 Interference” with the following additions/exceptions.

The following test configuration was performed:

UL RB=5
DL RB=16
Center Frequency = 710
REFSENS+0, REFSENS+3, and REFSENS+6

Due to system limitations, Channel 51 signal level only goes to -20 dBm

Test Results

Test Configuration

Parameter	Value
Channel 51 Signal	5.8 MHz, ATSC DTV signal centered at 695 MHz.
Channel 51 signal level	-50 dBm to -20 dBm
Uplink center carrier frequency	710 MHz
Downlink center carrier frequency	740 MHz
Nominal uplink bandwidth	10 MHz
Nominal downlink bandwidth	10 MHz
Uplink RB allocation	5 RBs with an offset of 45
Downlink RB allocation	16 RBs with an offset of 0
UE transmit power	Full (23 dBm)
LTE signal level	3 test cases: REFSENS, REFSENS+3, REFSENS+6

Find actual reference sensitivity of DUT with a criteria of 95% throughput. Downlink signal power is lowered by 0.5 dB steps until 95% throughput criteria is met.

Uplink Power Measurement:

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23.3	23	19.3	25.7	0.3	Inside

Starting Eqidistant Measurement...

Search Step	Downlink Level in dBm	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	-93.3	0.0	1350	100.000	93.820	Inside
2	-93.8	0.5	1350	100.000	93.820	Inside
3	-94.3	1.0	1350	100.000	93.820	Inside
4	-94.8	1.5	1350	100.000	93.820	Inside
5	-95.3	2.0	1350	100.000	93.820	Inside
6	-95.8	2.5	1350	100.000	93.820	Inside
7	-96.3	3.0	1350	100.000	93.820	Inside
8	-96.8	3.5	1350	100.000	93.820	Inside
9	-97.3	4.0	1350	100.000	93.820	Inside
10	-97.8	4.5	1350	99.926	93.820	Inside
11	-98.3	5.0	1350	100.000	93.820	Inside
12	-98.8	5.5	1350	99.926	93.820	Inside
13	-99.3	6.0	1350	100.000	93.820	Inside
14	-99.8	6.5	1350	100.000	93.820	Inside
15	-100.3	7.0	1350	99.926	93.820	Inside
16	-100.8	7.5	1350	100.000	93.820	Inside
17	-101.3	8.0	1350	93.481	93.820	Outside

Actual REFSENS value is -101.3 dBm

Next, use REFSENS value to test the impact of Channel 51 signals on the performance of the Band 12 test device, where LTE signal levels are set at (1) REFSENS, (2) REFSENS +3dB, and (3) REFSENS +6 dB; Use Channel 51 DTV signal levels starting at -50 dBm and increasing by increments of 1 dB until power level reaches -20 dBm.

REFSENS

Trace : [00:01:58] Setting DL power to -101.3 dBm. Expected uplink power 23.0 dBm.
Trace : [00:01:59] Setting DL power to -101.3 dBm. Expected uplink power 23.0 dBm.

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23	23	19.3	25.7	0	Inside

Starting Eqidistant Measurement...

Search Step	Interferer Power Offset in dB	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	0.0	0.0	1350	90.222	93.820	Outside
2	1.0	1.0	1350	84.815	93.820	Outside
3	2.0	2.0	1349	78.132	93.820	Outside
4	3.0	3.0	1350	78.222	93.820	Outside
5	4.0	4.0	1350	85.778	93.820	Outside
6	5.0	5.0	1350	71.778	93.820	Outside
7	6.0	6.0	1350	58.593	93.820	Outside
8	7.0	7.0	1350	57.778	93.820	Outside
9	8.0	8.0	1349	44.774	93.820	Outside
10	9.0	9.0	1349	26.316	93.820	Outside
11	10.0	10.0	1350	20.296	93.820	Outside
12	11.0	11.0	1348	11.499	93.820	Outside
13	12.0	12.0	1343	3.797	93.820	Outside
14	13.0	13.0	1333	3.301	93.820	Outside
15	14.0	14.0	1302	3.687	93.820	Outside
16	15.0	15.0	1325	1.585	93.820	Outside
17	16.0	16.0	1294	3.555	93.820	Outside
18	17.0	17.0	1307	2.831	93.820	Outside
19	18.0	18.0	1289	3.491	93.820	Outside
20	19.0	19.0	1288	3.339	93.820	Outside
21	20.0	20.0	1264	5.696	93.820	Outside
22	21.0	21.0	1220	7.459	93.820	Outside
23	22.0	22.0	1128	9.220	93.820	Outside
24	23.0	23.0	1094	7.770	93.820	Outside
25	24.0	24.0	1033	10.261	93.820	Outside
26	25.0	25.0	1004	8.068	93.820	Outside
27	26.0	26.0	978	5.010	93.820	Outside
28	27.0	27.0	966	6.625	93.820	Outside
29	28.0	28.0	940	5.745	93.820	Outside

REFSENS+3

Trace : [00:01:36] Setting DL power to -98.3 dBm. Expected uplink power 23.0 dBm.
Trace : [00:01:36] Setting DL power to -98.3 dBm. Expected uplink power 23.0 dBm.

Uplink Power Measurement:

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23.2	23	19.3	25.7	0.2	Inside

Starting Eqidistant Measurement...

Search Step	Interferer Power Offset in dB	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	0.0	0.0	1350	100.000	93.820	Inside
2	1.0	1.0	1350	100.000	93.820	Inside
3	2.0	2.0	1350	100.000	93.820	Inside
4	3.0	3.0	1350	100.000	93.820	Inside
5	4.0	4.0	1350	100.000	93.820	Inside
6	5.0	5.0	1350	100.000	93.820	Inside
7	6.0	6.0	1350	100.000	93.820	Inside
8	7.0	7.0	1350	100.000	93.820	Inside
9	8.0	8.0	1350	100.000	93.820	Inside
10	9.0	9.0	1350	100.000	93.820	Inside
11	10.0	10.0	1350	99.926	93.820	Inside
12	11.0	11.0	1350	100.000	93.820	Inside
13	12.0	12.0	1350	100.000	93.820	Inside
14	13.0	13.0	1350	100.000	93.820	Inside
15	14.0	14.0	1350	100.000	93.820	Inside
16	15.0	15.0	1350	100.000	93.820	Inside
17	16.0	16.0	1349	89.325	93.820	Outside
18	17.0	17.0	1345	73.309	93.820	Outside
19	18.0	18.0	1341	61.223	93.820	Outside
20	19.0	19.0	1326	47.964	93.820	Outside
21	20.0	20.0	1321	33.308	93.820	Outside
22	21.0	21.0	1274	23.391	93.820	Outside
23	22.0	22.0	1292	21.981	93.820	Outside
24	23.0	23.0	1235	21.943	93.820	Outside
25	24.0	24.0	1229	20.993	93.820	Outside
26	25.0	25.0	1157	27.139	93.820	Outside
27	26.0	26.0	1162	26.076	93.820	Outside
28	27.0	27.0	1145	26.288	93.820	Outside
29	28.0	28.0	1096	32.117	93.820	Outside
30	29.0	29.0	1059	37.016	93.820	Outside
31	30.0	30.0	1026	41.033	93.820	Outside

REFSENS+6

Trace : [00:02:12] Setting DL power to -95.3 dBm. Expected uplink power 23.0 dBm.
Trace : [00:02:12] Setting DL power to -95.3 dBm. Expected uplink power 23.0 dBm.

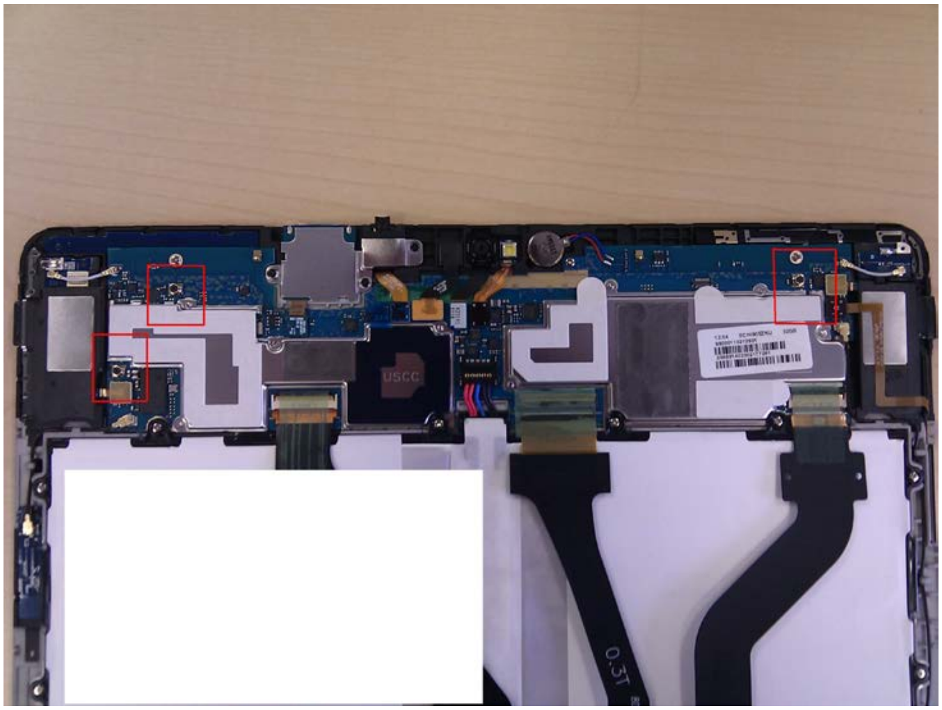
Uplink Power Measurement:

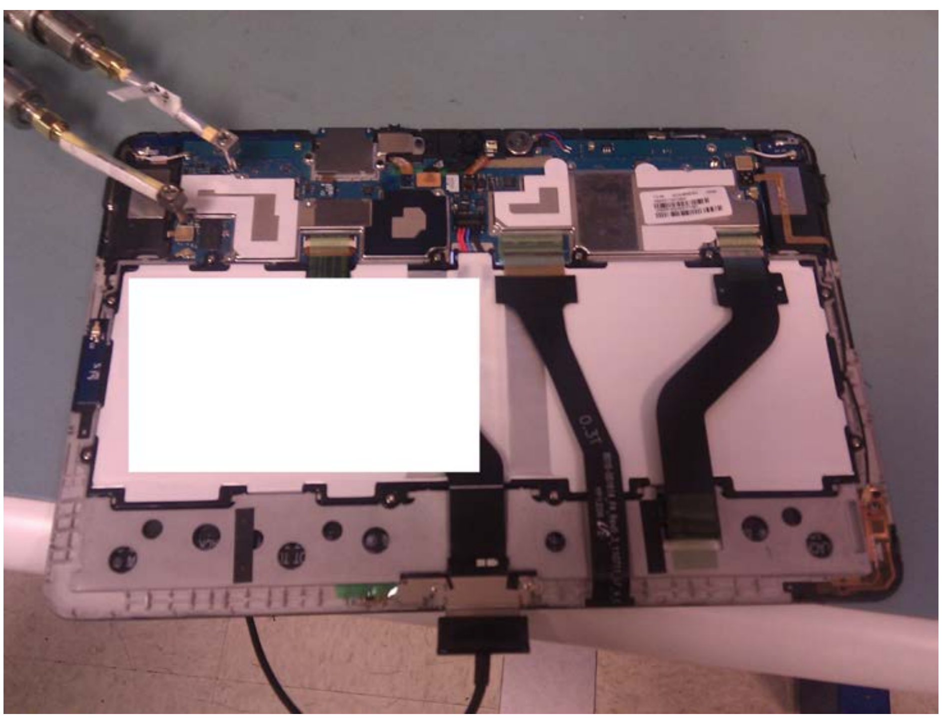
Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23.5	23	19.3	25.7	0.5	Inside

Starting Eqidistant Measurement...

Search Step	Interferer Power Offset in dB	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	0.0	0.0	1350	100.000	93.820	Inside
2	1.0	1.0	1350	100.000	93.820	Inside
3	2.0	2.0	1350	99.926	93.820	Inside
4	3.0	3.0	1350	100.000	93.820	Inside
5	4.0	4.0	1350	100.000	93.820	Inside
6	5.0	5.0	1350	100.000	93.820	Inside
7	6.0	6.0	1350	100.000	93.820	Inside
8	7.0	7.0	1350	100.000	93.820	Inside
9	8.0	8.0	1350	100.000	93.820	Inside
10	9.0	9.0	1350	100.000	93.820	Inside
11	10.0	10.0	1350	100.000	93.820	Inside
12	11.0	11.0	1350	100.000	93.820	Inside
13	12.0	12.0	1350	100.000	93.820	Inside
14	13.0	13.0	1350	100.000	93.820	Inside
15	14.0	14.0	1350	100.000	93.820	Inside
16	15.0	15.0	1350	100.000	93.820	Inside
17	16.0	16.0	1349	100.000	93.820	Inside
18	17.0	17.0	1350	100.000	93.820	Inside
19	18.0	18.0	1350	99.926	93.820	Inside
20	19.0	19.0	1350	100.000	93.820	Inside
21	20.0	20.0	1350	100.000	93.820	Inside
22	21.0	21.0	1332	85.736	93.820	Outside
23	22.0	22.0	1324	71.148	93.820	Outside
24	23.0	23.0	1309	66.157	93.820	Outside
25	24.0	24.0	1301	55.880	93.820	Outside
26	25.0	25.0	1253	49.481	93.820	Outside
27	26.0	26.0	1225	45.143	93.820	Outside
28	27.0	27.0	1203	45.387	93.820	Outside
29	28.0	28.0	1184	41.470	93.820	Outside
30	29.0	29.0	1161	40.138	93.820	Outside
31	30.0	30.0	1153	43.278	93.820	Outside

Photographs



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